Title: Catch and Release!

Link to Outcomes:

- **Problem Solving** Students will demonstrate their ability to solve real-life problems using mathematical reasoning in a cooperative atmosphere.

- **Communication** Students will demonstrate their ability to communicate mathematically in verbal and written form.

- **Reasoning** Students will demonstrate their ability to reason mathematically by making conjectures, gathering evidence, analyzing data, and making conclusions.

- **Connections** Students will demonstrate their ability to connect mathematics with real-life problems.

- **Estimation and Computation** Students will demonstrate their ability to apply estimation strategies with the use of technology in problem solving. They will determine the reasonableness of solutions.

- **Arithmetic Operations** Students will write the appropriate proportion and solve it.

- **Number Relationships** Students will demonstrate their ability to apply ratios and proportions.

- **Statistics** Students will demonstrate their ability to collect and organize data and to extract information from their data.

- **Probability** Students will demonstrate their ability to use simulations to develop a model for real-life situations.

Brief Overview:

Students will discuss and compare different methods of estimating population of animals in the wild. In groups, students will experiment with various samples using the method of capture-and-recapture. Using a simulation as a basis for prediction, the students will estimate the size of the Rockfish population in a simulated Chesapeake Bay.

Grade/Level:

Grades 6, 7, & 8

Duration/Length:

This unit should take at least 2-3 class periods.

Prerequisite Knowledge:

Students should have a working knowledge of the following skills:

- solving proportions
- collecting data

- rounding numbers
- interpreting data
- making hypotheses
- drawing conclusions

Objectives:

Students will:

- work cooperatively in groups.
- collect and organize data from "bingo chips" samples.
- make predictions through estimation.
- develop a model for predicting the number of Rockfish in a simulated Chesapeake Bay.
- write proportions to solve the problem of "How many Rockfish are in the Bay?"
- support answers based on data from experiments.
- make a hypothesis and determine a conclusion based on data from simulations.

Materials/Resources/Printed Materials:

- Two different-colored bingo chips, beans or goldfish crackers
- Bowl or bag that will contain chips (1 per group)
- Calculators (1 per student)
- Worksheets (1-9)
- Web Worksheet
- Pencils

Development/Procedures:

Introduction:

- Arrange class into groups of three or four (depending on class size).
- Distribute materials and worksheets to each group.
- Give a brief overview of the unit and activities.

Activity 1:

- Have groups discuss different methods for estimating wildlife populations.
- Have students complete the Web worksheet of the possible methods for estimating.

Activity 2:

- Have each student select the method he/she thinks is the best and explain, in writing, why he/she chose this method.

Activity 3:

- Have groups share their ideas with the entire class.
- Explain the capture-recapture method to the students.

Activity 4:

- Have students estimate how many fish (counters, etc.) are in their bowl.
- Have students "tag" their fish by capturing some of them and exchanging these for another color; then record the number.
- Have students repeat this exercise, taking random samples from their bowl and recording the total number as well as the tagged number of the sample. Have students total their results.
- Have students use their results in the capture-recapture proportion to calculate the number of Rockfish in the simulated Chesapeake Bay.
- Let students compose a written comparison of their original estimates to the capture-recapture calculation.

Activity 5:

- Have students repeat the capture-recapture process to complete worksheet 6.
- Have students use the capture-recapture proportion again to find a new estimate for fish in the bowl.

Activity 6:

- Let students count and record the actual number of fish in their bowl.

Activity 7:

- Have students complete a written comparison of their original estimate with the actual number of fish in the bowl.
- Have students write a comparison of their original estimate with the results of their two experiments.
- Have students answer questions on the effects of increased trials and tag loss.
- Have students suggest factors that might influence the accuracy of this method in real-life situations and write a summary of their ideas.
- Have students list animals that could or could not be counted by this method and justify their reasoning.

Evaluation:

Students will be evaluated based on the following criteria:

- Group participation and performance
- Individual completion of worksheets
- Adherence to proper written form by answering the questions in detail with complete sentences
- Validity of results

Extension/Follow Up:

- Activity extensions: Continue to extend the number of trials. Compute the percent accuracy and make a graph of the results. Compare group results from the entire class. Compute percent accuracy and make a graph of the results.

- Internet extension: Share and compare data with another school using e-mail.

- Outside resources
  extension: Obtain a speaker from the Department of Natural Resources or a park service to discuss methods of estimating populations of wildlife.

  Show a video on estimating wildlife.

  Take a field trip to a fish hatchery or a wildlife sanctuary.

- Research extension: Consult almanacs to find actual wildlife populations. Write reports on endangered species.

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Catch and Release

How do you think scientists calculate the population of wildlife, such as deer, fish, penguins, and other animals?

Today we will discuss, experiment, and analyze methods of estimating the population of wildlife in a given area..

Group Activity
Activity 1
In your group, discuss some methods scientists might use to calculate the population of a certain animal. Discuss and compare the advantages and disadvantages of each method. Use the chart below to record your methods.

Method	Advantage	Disadvantage

Class Activity
Activity 2

Share your ideas and the ideas of your group with the rest of the class. Record any new methods in your chart.

Individual Activity
Activity 3
Select the best method your class discussed and describe it below. Explain why you chose this method of calculating the population of an animal in a given area . Write your response in complete sentences.

_____

_____

_____

_____

_____

Scientists often use a method called *Capture-Recapture* to calculate the population of wildlife.

Scientists begin by *capturing* a sample number of the animal and tagging them. Then they release the tagged specimens. Next the scientists *capture additional* samples. They count the number of animals in each sample and the number of those that are tagged. (The tagged animals are called *recaptured*.) After several samples have been collected, the scientists use a mathematical formula to estimate the actual population of the animal.

Group Activity
Activity 4

Using the Capture - Recapture method of calculation, we are going to estimate the population of Rockfish in a simulated Chesapeake Bay.

For our simulation, we will use a bowl or a bag as the Chesapeake Bay and bingo chips for the Rockfish.

In your group, estimate the number of fish in your bowl. Record your estimate.

_____ Estimated number of Rockfish in bowl.

Begin by capturing a random number of fish and tagging them. Exchange the chip for a different colored one to identify the fish as being tagged. Record the number of tagged fish below .

_____ Original Number of tagged fish.

You are now going to take samples from your bowl and record the data in the chart below. Begin by choosing a random sample of fish. Count the total number *captured* (the number in your hand) and the total number *recaptured* (previously tagged fish). Record the data in the chart below, replace the fish, mix the fish in the bowl, and repeat the process until your chart is complete.

Trials	Captured (in hand)	Recaptured (already tagged)
A		
B		
C		
D		
E		
F		
G		
H		
I		
J		
TOTALS		

Scientists would use the following proportion to estimate the population of Rockfish in the Chesapeake Bay.

Original Captured   Total Tagged
(original tagged)   in samples (recaptured)

Number of Rockfish   Total Captured
in Chesapeake Bay   in samples

$$\frac{\text{Original Captured (original tagged)}}{\text{Number of Rockfish in Chesapeake Bay}} = \frac{\text{Total Tagged in samples (recaptured)}}{\text{Total Captured in samples}}$$

Use the above formula to calculate the number of Rockfish you collected in the Chesapeake Bay. Use the space below for your calculations.

_____Calculated number of fish in bowl.

What was your original estimate? _____

Compare your calculation from the Capture - Recapture formula to your original estimate. Answer in complete sentences.

_____

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_____

Group Activity
Activity 5

Repeat the same process again using the same number of originally tagged chips. Complete the chart below.

Trials	Captured (in hand)	Recaptured (already tagged)
A		
B		
C		
D		
E		
F		
G		
H		
I		
J		
K		
L		
M		
N		
O		
P		
Q		
R		
S		
T		
Totals		

Now use the formula again to calculate the number of Rockfish in your bowl. Use the space provided below for your calculations.

_____ Calculated number of fish in bowl.

Group Activity
Activity 6

Now count the fish in your bowl. Record below.

_____ Actual number of fish in bowl.

Individual Activity
Activity 7

How did your first estimate (from the beginning of Activity 4) compare with the actual amount?

_____

_____

_____

_____

_____

How did the calculations from your two experiments compare with the actual amount?

_____

_____

_____

_____

_____

What do you think would happen to your calculated amount if you were to increase the number of trials ?

_____

_____

_____

_____

_____

What would happen to your calculated amount if some of the tags wore off?

_____

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_____

_____

_____

What factors might effect the accuracy of this method of calculating animal populations in real-life situations?

_____

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_____

The Capture - Recapture Method of estimating populations of animals works well with fish. For what other animals would this method work and why? With what animals would this method not work and why?

_____

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